THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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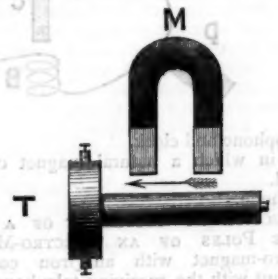
MR. HERRING'S INSTRUMENT.

THE letter from a correspondent which we publish in the present number of the Journal contains remarks which have much truth in them. They are evidently the opinions of a skilled practical telegraphist, who from long experience is well qualified to know the value of any improvements that may be suggested in the existing forms of telegraph instruments. The opinion of the writer of the letter is not, of course, necessarily a strictly correct one, though the arguments seem plausible in the main. In the case of Mr. Herring's printing telegraph which we described in our issue for Dec. 15, we have had opinions as to its merits expressed by men who are well known as eminent scientific experts, and whose names are household words in the electrical world, and now we also have the opinion of a practical telegraphist, which, as we desire only to be fair, we would recommend to the notice of our readers. The general public and probably also inventors give their verdict on this question on the side of the eminent scientific authorities who have been invoked. But a mere blind following of the opinion of scientific experts and men of name is not to be upheld. The judgment of such men on particular points is practically law, and correctly so; and their opinion on subjects which, to a certain extent, lie outside their own sphere of work, in many cases is also extremely valuable, simply from the fact that their natural astuteness enables them in many cases to see clearly at first sight the exact facts of the case; but this does not make their decision on all matters connected with their profession an infallible one. A man may be a perfect pianist, but it does not therefore follow that he is competent to say whether a violinist handles his bow properly, or whether a new form of bow is more suitable for the purpose than those previously used. In order to determine that matter it is absolutely necessary for him to possess a knowledge of the instrument in question. So it is in telegraphy; a thorough knowledge of the systems, that are being attempted to be improved, is absolutely necessary before a correct opinion can be arrived at, and this can only be obtained by lengthened experience. We do not mean to say that it is useless therefore to attempt to introduce improvements into systems of which a thorough knowledge is not possessed, but there is perhaps, a certain tendency in inventors to feel convinced that they know much better what improvements are wanted than those who have had to deal with the object which the inventor is desirous of remodelling or superseding. On the other hand, there is equally a tendency the other way, viz.: for those in authority to reject any proferred aid from outsiders, a natural inertia to suffer change, and perhaps also a feeling of wounded professional egotism because the improvement in question did not originate with them. Now, the fact that these discordant tendencies exist on both sides, seems to us to call for a competent and independent third party which would mediate between inventors and telegraph officials. We have already advocated such a course in pointing attention to the Commission of experts appointed to recommend inventions to the authorities, in France and other Continental countries, and it still appears to us to be the link required for the harmonious interaction of outside inventors and the Government telegraph service of England.

A CURIOUS TELEPHONIC EXPERIMENT.

A SINGULAR experimental effect, of special interest just now from its possible bearing on the theory of the source of sound in the Bell telephone, has just been observed by Mr. Stroh, the well known mechanician. If a telephone T, with the circuit of its coil left open, be held to the ear, and a powerful magnet M be moved gently up and down along the length of the magnet, as shown by the arrow, and at a distance of an inch or two from it, a faint breathing sound will be heard; the recurring pulses of sound keeping time with the up and down motion of the magnet. The sound may be aptly compared to the steady breathing of a child, and there is a striking resemblance between it and the microphonic sounds of gases diffusing through a porous septum as heard by Mr. Chandler Roberts.



We understand that Prof. Hughes is investigating the cause of this curious sound by help of the microphone.

EXPERIMENTAL INVESTIGATIONS BY AID OF THE TELEPHONE AND MICROPHONE.

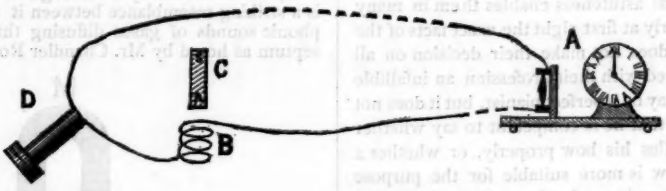
By PROF. D. E. HUGHES.

INDUCED CURRENTS.—Up to the present time the microphone has only been used in connection with voltaic currents, but it has also a remarkable power when connected with an ordinary telephone to detect induced currents too feeble to be observed upon a galvanometer, and also too feeble to be heard by the telephone alone. In order to detect feeble voltaic or induced currents upon the telephone, unaided by the microphone, we should construct a De la Rive's Rheotome, in order that by sufficiently rapid interruptions and contacts, a sufficient number of vibrations of the diaphragm may be obtained to produce a tone sensible to the human ear.

The microphone, however, when used with a clock or any other source of sound, not only transmits the regular beats of the clock, but all its timbre and its infinite varieties. Thus, a clock which beats half seconds, would in a second give four complete waves of sound, and superposed on these an infinite number of variations due to the timbre of the source of sound, consequently the waves of electricity transmitted instead of taking a uniform curve, would be represented graphically thus :—

And we shall see in some following experiments how fully it serves the object intended, giving them a power of research into feeble induced currents that we have hitherto not possessed.

In the following first series of experiments no voltaic currents were used. The microphone in a distant chamber being connected direct to the coil or organ under investigation, thence to the telephone and return wire, thus :—



A, microphone and clock.

B, coil in which a natural magnet C, can be introduced.

D, telephone.

I.—INDUCTION BY MOVEMENT OF A MAGNET NEAR THE POLES OF AN ELECTRO-MAGNET.—An electro-magnet with an iron core being put in circuit with the receiving telephone, no battery being employed, and a magnet made to touch the iron core, distinct tones could be heard in the telephone, confirming what had already been observed by many experimenters; but if the magnet was moved to ¼ inch distance, and oscillated through a small space, no sound could be heard, consequent upon the current generated being feeble and not of sufficient rapidity to produce an audible sound. If, however, under these conditions, one of the wires connecting the electro-magnet to the telephone line was cut, and the ends put together again in a loose contact, with but a slight pressure, so that by a constant vibration of the first wire, the circuit was made and broken with great rapidity, clear crackling tones could be heard by simply holding the magnet near the electro-magnet, and it is impossible to hold with the hand the magnet steady enough not to produce innumerable induction currents, plainly perceptible on the telephone. That these currents are due to the unstable position of the magnet whilst in the hand, is proved by firmly fixing the magnet in a strong mechanical support, when the sounds are no longer audible.

II.—In place of the vibrating contact above described, the transmitting microphone with clock, but without battery, was employed; louder sounds could now be heard, or rather the beats of the clock, by simply moving the natural magnet near the poles of the electro-magnet. If we replaced the electro-magnet by a simple coil the clock could be distinctly heard when the magnet passed near to the coil, but more so when the magnet was introduced into the coil. The coil having an inside diameter of 2 inches, allowed the magnet to be drawn through it easily without touching it. It was remarkable how continuous this induced current became when we moved the magnet slowly through the coil, thus for a magnet only 6 inches long, we obtained a continuous current during a slow passage of 3 seconds. If the magnet moved quickly, sounds were equal to 1 Daniell element; but when the magnet moved very slow the sounds were faint but continuous. This arrangement proves itself to be a most sensitive and useful means of demonstrating feeble induced currents—too feeble to be perceived by any other known means.

III.—If in place of moving the magnet near the coil, we move the coil itself near the telephone to which we are listening, we then hear distinctly the clock upon the microphone; but if we suppress the microphone we hear no sounds or production of induced currents by the movement of the coil near the telephone.

IV.—If we suppress the coil, having simply in circuit the microphone and telephone (without battery), we can hear the clock sounds, simply by moving a strong bar magnet near the telephone to which we are listening, and we have thus obtained articulate sounds which were perfectly understood.

Here we have the remarkable fact, that the coil of the telephone that produces the current, also, at the same time, by aid of the variations produced by a microphone, serves to reproduce upon its diaphragm the sounds transmitted to it from a distant station.

V.—The above experiment may be varied by joining the microphone circuit direct to a coil of an electro-magnet, and the telephone to a secondary coil surrounding the primary coil. Thus the microphone is in the primary circuit, and the telephone in the secondary, both direct and without battery. If now we move a natural magnet near the two coils, we hear perfectly the sounds transmitted by the microphone. We have here simultaneously double induced currents, re-acting on each other directly in proportion to the innumerable variations of resistance introduced into the primary circuit by the microphone.

VI.—Instead of using a coil and magnet we may connect two telephones in direct circuit with the microphone, and upon pressing gently upon the diaphragm of one, and listening with the other, we hear distinctly the sounds transmitted by the microphone, but not those due to the movement of the finger upon the diaphragm of the telephone; and with a diaphragm of thin charcoal iron, the slightest pressure of the finger upon it, is sufficient to make the microphone sounds audible, and if this pressure is slightly but continuously varied, we hear the microphone sounds as continuously.

Many similar experiments could be cited, but we deem that the ones already mentioned are sufficient to prove that we possess in the telephone and microphone powerful aids to the investigation of feeble magneto currents. In some following experiments we will show how remarkable are its powers in relation to currents induced by voltaic electricity.

THE BRUSH ELECTRIC LIGHT.

THE dynamo-electric machine of Mr. Brush, which was patented in England last year (patent No. 2,003) is attracting considerable attention just now in America, where it divides public favour with the Wallace-Farmer machine (see TELEGRAPHIC JOURNAL, Vol. 6, p. 431), in much the same way as the Siemens' machine rivals the Gramme in this country. It is neat and simple in construction, readily open to inspection, and requires no special attendance when running. Fig. 1 is a view of the machine as it stands, and fig. 2 is a longitudinal section of it along the centre line, while fig. 3 is a vertical section across the middle. It will be seen that it consists essentially of two horse-shoe magnets H H, placed with their like poles N N, S S, opposite each other, but far enough apart to allow a coiled armature A to rotate between in the usual manner, the currents being drawn off by hard metal brushes rubbing against a commutator E, on the shaft to which the armature coils are connected The novelties of the machine consist in the arrangement of the armature and the commutator. The armature A (fig. 1 and 2), consists of a soft iron wheel, preferably cast, with a heavy rim, fixed by the hub B to the shaft C, which is driven by a belt on the pulley D. The continuous rim of this wheel is niched out at regular intervals, and insulated copper wire is coiled into each niche in the same direction for all. In the machine represented there are eight separate coils, each occupying a niche in the rim. In the Gramme armature the iron ring has a uniform cross section in every part; but Mr. Brush claims for the niched ring that the projecting parts between the coils are brought closer to the poles of the electro-magnets N, S, where they experience stronger induction, and that these exposed surfaces help to radiate away the heat generated in the ring by the rapid changes of magnetism which take place in it. It is a peculiar feature, too, of these American machines, the Brush and Wallace-Farmer, that the cores of the armature and electro-magnets are sometimes perforated, as shown in fig. 1, by cylindrical holes, for the double purpose of getting rid of superfluous material and increasing the heat radiating surface. Another improvement patented by Mr. Brush consists in insulating from one another, either wholly or in part, the two halves of the armature core which would be obtained by splitting it in its own plane. The object of this device is to prevent the electric currents induced in the core itself by its motion in the magnetic field from circulating entirely across the rim. By splitting up the rim in its own plane, and interposing insulating material between the halves, these currents (which traverse the rim in a direction at right-angles to the direction of its motion) are cut off and confined in their flow to each half of the cross section, and their heating effect diminished. Instead of employing a layer of insulating substance between the halves of the rim, Mr. Brush also cuts a deep narrow groove round the periphery of the latter, and in this way, without entirely splitting the rim, he inserts an insulating layer of air, and secures the advantages which he aims at. A second groove (shown in fig. 1) is cut round the *sides* of the rim, for a similar purpose.

The arrangement of the commutator is sketched in figure 4. Each pair of opposite coils on the armature A are connected together, the end of one being joined across to the beginning of the other, as shown at 3 and 7; and the other ends being connected respectively to contact segments S 3 and S 7 of the commutator E carried by the shaft. These contacts are insulated from each other, and form the positive and negative poles of the two coils joined together. Brush contacts (F F, fig. 3) rubbing against these as they revolve, conduct away the current generated. The two segments, S 3 and S 7, corresponding to coils 3 and 7 of the armature, hold a position on the cylinder E in advance of those of the preceding coils, S 2 and S 6, to the same angular extent that the coils 3 and 7 are removed from 2 and 6 on the armature, so that the brushes draw off currents of equal strength from each succeeding pair of coils and in this way maintain the uniformity of the resultant current. When a coil is passing the "neutral" points, at right-angles to the line joining the poles of the inducing magnets N S, the plates F are in contact with the insulating material inserted between the corresponding contacts on the cylinder E, and thus the coil in question, which is

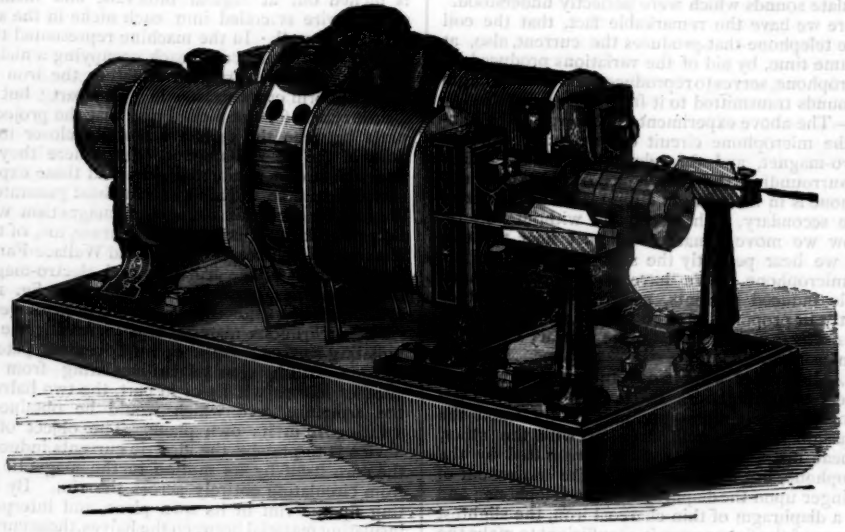


FIG. 1.

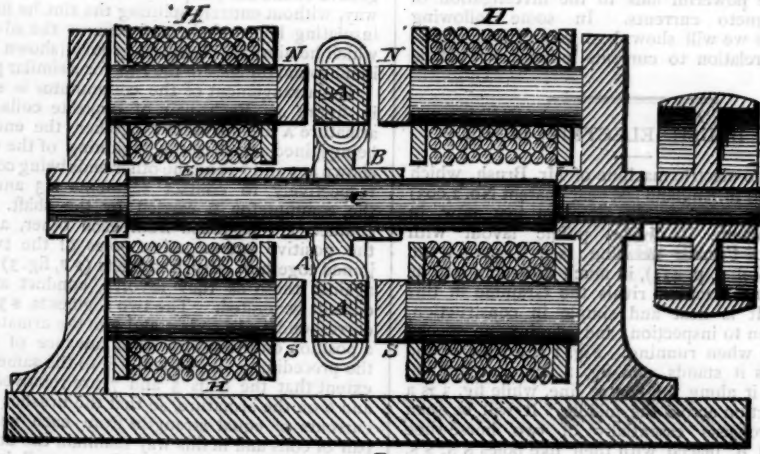


FIG. 2.

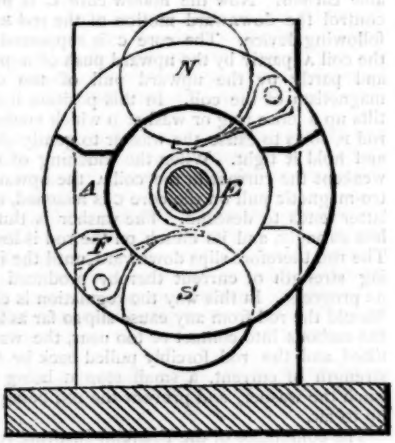


FIG. 3.

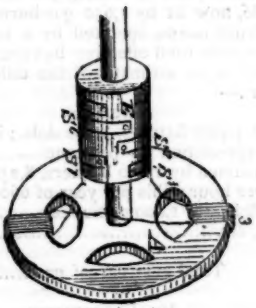


FIG. 4.

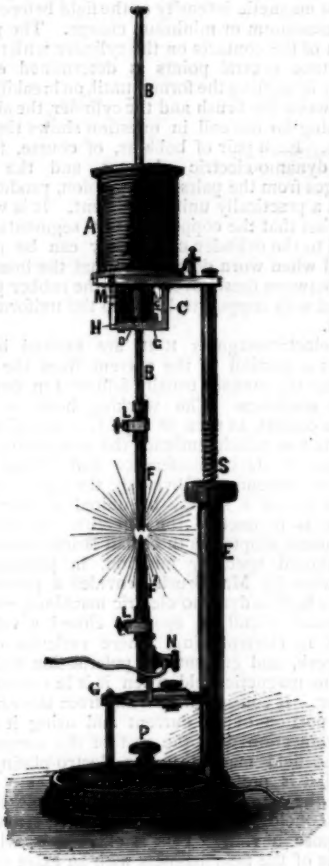


FIG. 5.

for the time inactive, is cut out of circuit in order that it may not shunt off part of the current generated by the active coils. In fact, the insulating spaces are made experimentally so wide that each coil is cut out of circuit except when it is producing its maximum of current. In practice it is found that the neutral points of the armature in motion are considerably in advance of their theoretical position, perhaps because some time is required to saturate any parts of the armature with magnetism, so that it is really carried beyond the points of greatest and least magnetic intensity of the field before attaining its maximum or minimum charge. The proper position of the contacts on the cylinder with respect to the true neutral points is determined experimentally by shifting the former until, on breaking contact between the brush and the cylinder, the absence of sparking for the coil in question shows that it is inactive. Each pair of bobbins, of course, form a single dynamo-electric element, and the rapid discharges from the pairs in succession, produce the effect of a practically uniform current. It is worthy of mention that the copper contact segments S, are so fixed to the cylinder E that they can be readily replaced when worn down; and that the insulating spaces between these, over which the rubber passes, are faced with copper to keep up the uniformity of material.

The electro-magnets H H, are excited by the whole or a portion of the current from the armature, after the manner usually followed in dynamo-electric machines. The working holes of these magnets consist, as seen in figs. 1, 2, and 3, of iron segments N S, which embrace the armature for the most part of its circumference and spread their inductive influence. Obviously the opposite segments N N, and S S, may be united at their outer edges so as to enclose the armature yet more, an arrangement adopted in the small Brush machines.

We should specially mention, in passing, the means whereby Mr. Brush provides a permanent magnetic field in dynamo-electric machines, whether the external circuit be open or closed, a valuable property in electrotyping, where varieties of external work, and currents of polarisation seriously affect the magnetic field when it is in circuit with the latter. It consists in *diverting* from the external work a portion of the current and using it alone, or in connection with the rest of the current, to work the field magnets. For electro-plating the latter plan is preferable. In both of these cases, whether the external circuit is open or closed, the magnetic field will remain sufficiently strong for the purpose in view. This is effected by winding the cores of the field magnets with an extra circuit, having a resistance high in comparison with that of the external circuit, so that the portion of current which it diverts from the latter may not materially reduce the working current.

We come now to the Brush electric lamp which is shown in fig. 5. It consists of a stand E, supporting the regulator A, and the two carbons F F'. These carbons, of which F is positive, and F' negative, are fixed by clamp sockets L L. By a slide G, the position of the lower carbon can be set with respect to the upper. P and N are terminals to which are connected the leading wires from the machine. The carbons are coated with copper or nickel to prevent undue wastage of their substance when emitting light. The current from P passes up the support E with its adjustible screw socket S, and through the coil of the regulator A; thence down the metal rod B and through the carbons, thus completing the circuit. The regulator is an ingenious electro-magnetic arrangement, somewhat similar to that obtaining in the Wallace-Farmer lamp. It consists of a hollow electro-magnet A, enclosing a hollow soft iron core C, which again encloses the rod B, which carries the upper or moveable carbon. Now the hollow core C is made to control the downward motion of the rod B by the following device. The core C is supported within the coil A partly by the upward push of a spring C', and partly by the upward pull of the electro-magnetism of the coil. In this position it slightly tilts up a loose ring or washer D which encloses the rod B, so as to cause the washer to gently clutch B, and hold it tight. When the widening of the arc weakens the current in the coil A, the upward electro-magnetic pull on the core C is lessened, and the latter tends to descend. The washer is thus tilted less strongly, and its clutch on the rod is loosened. The rod therefore slips downward until the increasing strength of current thereby produced arrests its progress. In this way the regulation is effected. Should the rod from any cause slip so far as to bring the carbons into contact or too near, the washer is tilted and the rod forcibly pulled back by the full strength of current, a small stop G being set to catch the washer, and prevent the rod being pulled up to far.

The committee of the Franklin Institute reported very favourably on the Brush machine. They considered it well adapted for lighting purposes, and easy of repair, while giving currents of widely different electro-motive force at will. We learn from America that Brush's system is being introduced into a number of large cloth factories in the United States, one of which, 380 feet long by 220 feet wide, now lit by 1,650 gas-burners, will be lit by 20 Brush lamps, operated by a single machine, with the same total effective lighting power. The following is an estimate of the difference in cost per year :—

By Gas.	Dols.
Burners, pipes, fixtures, 1,500 dols.; interest and depreciation 12 per cent.	180
Gas consumed by 1,650 burners, 8,250 cubic feet per hour; this per year of 660 hours, at 2 dols. per 1,000 cubic feet	10,890
Repairs, &c.	50
Total per year of gas ..... Dols.	11,120

By Electricity.	
One large Brush machine, 3,250 dollars; lamps, 250 dols.; total plant, 3,500 dols.; interest and depreciation 15 per cent. ...	525
Driving power—12 horse-power taken from 100 horse-power engine which drives the works; the cost practically nothing, but estimating at cost of special engine.....	76
Carbon, 4 cents. per hour per lamp.....	528
Wages of one attendant, 25c. per hour	165
Small expenses, oil, waste, &c., estimated at	100
Total of electricity ..... Dols.	1,394

CIRCUMSTANCES INFLUENCING THE EFFICIENCY OF DYNAMO-ELECTRIC MACHINES.*

By Profs. Edwin J. Houston and Elihu Thomson.

During the recent competitive trials made at the Franklin Institute, as to the relative efficiency of some different forms of dynamo-electric machines, the authors have been entrusted with the work of determining the relations between the mechanical power consumed, and the electric and thermic effects produced, took the opportunity thus afforded, to make a careful study of many interesting circumstances which influence the efficiency of these machines.

It is proposed in the present paper, to select from the many circumstances thus noticed, a few of the more interesting, reserving the others for a future consideration.

It will readily be understood, from the comparatively new field in which we had been working, no reliable data of the electrical work of these machines having before been obtained, that difficulties constantly arose owing to necessary conditions of operation, and new developments as to the behaviour of the machines under varied conditions, were constantly met.

A convenient arrangement of the particular circumstances we are about to discuss may be, 1st, Those affecting the internal work of the machine; 2nd, Those affecting the external work, and 3rd, The relations between the internal and external work.

The mechanical energy employed to give motion to a dynamo-electric machine is expended in two ways, viz., 1st, In overcoming friction and the resistance of the air; and, 2nd, In moving the armature of the machine through the magnetic field, the latter of course constituting solely the energy available for producing the electrical current. The greatest amount of power expended in the first way, was noticed to be about 17 per cent. of the total power employed. This expenditure was clearly traceable to the high speed acquired by the machine. The speed, therefore, required to properly operate a machine is an important factor in ascertaining its efficiency.

The above percentage of loss may not appear so great, but when it is compared with the total work done in the arc, as heat, constituting as it did in this particular instance over 50 per cent. of the latter, and about 33 per cent. of the total work of the circuit, its influence is not to be disregarded.

In another instance, the work consumed as friction was equal to about 80 per cent. of that appearing in the arc as heat, while in the Gramme machine experimented with, this percentage fell to 20 per cent. of that which appeared in the arc as heat, and was only about 7 per cent. of the total power consumed in driving the machine.

In regard to the second way in which mechanical energy is consumed, viz.: in overcoming the resistance necessary to move the armature through the magnetic field, or in other words, to produce electrical current, it must not be supposed that all this electrical work appears in the circuit of the machine, since a considerable portion is expended in producing what we term the local action of the machine, that is local circuits in the conducting masses of metal, other than the wire, composing the machine.

The following instances of the relation between the actual work of the circuit, and that expended in local action, will show that this latter is in no wise to be neglected. In one instance an amount of power somewhat more than double the total work of the circuit was thus expended. In this instance also it constituted more than five times the total amount of power utilised in the arc for the production of light. In another instance it constituted less than one-third the total work of the circuit, and somewhat more than one-half the work in the arc.

Of course work expended in local action is simply thrown away, since it adds only to the heating of the machine. And since the latter increases its electrical resistance, it is doubly injurious.

The local action of dynamo-electric machines is analogous to the local action of a battery, and is equally injurious in its effects upon the available current.

Again, in regard to the internal work of a machine, since all this is eventually reduced to heat in the machine, the temperature during running must continually rise until the loss by radiation and convection into the surrounding air, are eventually equal to the production, and the machine will at last acquire a constant temperature. This temperature, however, will differ in different machines according to their construction, and to the power expended in producing the internal work, being, of course, higher when the power expended in producing the internal work is proportionally high.

If therefore a machine during running acquires a high temperature when a proper external resistance is employed, its efficiency will be low. But it should not be supposed that because a machine when run without external resistance, that is on short circuit, heats rapidly, that inefficiency is shown thereby. On the contrary, should a machine remain comparatively cool when a proper external resistance is employed, and heat greatly, when put on short circuit, these conditions should be regarded as an index of its efficiency.

As a rule the internal resistance of dynamo-electric machines is so low that to replace them by a battery, the latter, to possess an equal internal resistance, would have to be made of very large dimensions, so that the efficiency of Dynamo-Electric Machines, cannot be stated in terms of battery cells as ordinarily constructed.

In regard to the second division, viz., the external work of the machine, this may be applied in the production of light, heat, electrolysis, magnetism, &c.

Where it is desired to produce light, the external resistance is generally that of an arc formed between two carbon electrodes; the resistance of the arc is therefore an important factor in determining the efficiency. To realise the greatest economy, the resistance of the arc should be low, but nevertheless should constitute the greater part of the entire circuit resistance.

In some of our measurements the resistance of

* Paper read before the American Philosophical Society, Nov. 1st, 1878.

the arc was surprisingly low, being in one instance 54 ohm., and in another ·79 ohm. It was, however, in some instances as high as 3·18 ohms.

It may be noted as an interesting fact that where the greatest current was flowing, the resistance of the arc thereby produced was low. This is undoubtedly due to higher temperature and increased vaporization from the carbons. In this latter case also the greatest amount of light was produced.

The amount of work appearing in the arc as measured by the number of foot pounds equivalent thereto, is not necessarily an index of the lighting power. In two instances of measurement, the amount of energy thus appearing in the arc was equal, while the lighting powers were proportionately as three to four. This apparent anomaly is explained by considering the resistance of the arc, it being much less in the case in which the greater light was produced. The heat in this case being evolved in less space, the temperature of the carbons, and therefore their light-giving powers, was considerably increased.

A few remarks on the economical production of light from an electrical current may not be out of place. The light emitted by an incandescent solid will increase as its temperature is increased. In the voltaic arc the limit to increase of temperature is in the too rapid vaporization of the carbon. Before this point is reached, however, the temperature is such that the light emitted is exceedingly intense. No reliable method of measuring the temperature of the arc has as yet been found.

A well known method of obtaining light from electrical currents is by constructing a resistance of some material such as platinum, having a high fusing point and heated to incandescence by the passage of a current. When platinum is employed the limit to its increase of temperature is the fusing point of the platinum, which is unquestionably but a fraction of the temperature required to vaporize carbon. Were the falling off in the amount of light emitted merely proportional to the decrease in temperature, the method last described might be economical. Unfortunately, however, for this method, many facts show that the decrease in the light emitted is far greater than the decrease of the temperature. Most solids may be heated to 1000° F., without practically emitting light. At 2000° F. the light emitted is such that the body is said to be at a bright red. At 4000° F. the amount of light will have increased far more than twice, probably as much as four times that emitted at 2000° F. It is reasonable to suppose that with a further increase of temperature the same ratio of increase will be observed, the proportionate increase in luminous intensity far exceeding the increase in temperature.

It would therefore appear that the employment of a resistance of platinum or other similar substance, whose temperature of alteration of state as compared with that of carbon is low, must be far less economical than the employment of the arc itself, which as now produced has been estimated as about two or three times less expensive than gas.

Indeed it would seem that future improvements in obtaining light from electrical currents will rather be by the use of a sufficient resistance in the most limited space practicable, thereby obtaining in such space the highest possible temperature.

Perhaps the highest estimate that can be given of the efficiency of dynamo-electric machines as ordinarily used, is not over 50 per cent. Our measurements have not given more than 38 per cent. Future improvements may increase this proportion. Since the efficiency of an ordinary steam engine and boiler in utilising the heat of the fuel is probably over estimated at 20 per cent., the apparent maximum percentage of heat that could be recovered from the current developed in a dynamo-electric machine, would be over estimated at 10 per cent. The economical heating of buildings by means of electricity may therefore be regarded as totally impracticable.

Attention has, long ago, been directed to the use of dynamo-electric machines for the conveyance of power. Their employment for this purpose would indeed seem to be quite promising. Since in this case one machine is employed to produce electrical currents, to be reconverted into mechanical force by another machine, the question of economy rests in the perfection of the machines and in their relative resistances.

In respect to the relations that should exist between the external and internal work of dynamo-electric machines, it will be found that the greatest efficiency will, of course, exist where the external work is much greater than the internal work, and this will be proportionately greater as the external resistance is greater. Our measurements gave in one instance the relation of ·82 ohm. of the arc to ·49 ohm. of the machine, a condition which indicates economy in working. The other extreme was found in an instance where the resistance of the arc was 1·98 ohms., while that of the machine was 4·60 ohms. a condition indicating wastefulness of power.

D'ARLINCOURT'S AUTOGRAPHIC TELEGRAPH.

IN the number of the Journal for Dec. 15th we gave some illustrations of results obtained by means of this ingenious form of telegraph instrument. We now give some details of the arrangements by which the apparatus is worked.

The general principle of the system is similar to that of the copying telegraph of Bakewell. The principle of this latter instrument is as follows :—

The apparatus at the transmitting and receiving stations are similar; at each there is a metallic drum, which is caused to rotate at a uniform rate of speed by clockwork mechanism. A toothed wheel fixed to one end of the cylinder gears into a pinion fixed on an axis which runs parallel with the axis of the cylinder, and which has a fine screw thread cut on it from end to end; a nut works on this screw, and has attached to it an arm with a metal style at the end, which presses against the surface of the drum. It is evident that the continuous rotation of the drum will cause the style to be carried along parallel to the axis of the former, and consequently to trace a continuous spiral line on the surface of the drum. Similar forms of apparatus being at the two stations, the drums are connected to the ends of the line wire, the style at the transmitting station being connected to the

positive pole of a battery, whose other pole is to earth; and at the receiving station the style is connected to earth.

At the sending station, the message or design to be transmitted is written on tin foil with an insulating ink, and wrapped round the drum, whilst at the receiving station a sheet of paper wetted with a chemical solution, as in the Bain apparatus, is placed on the drum. As the two drums are caused by mechanism to rotate synchronously, and as the styles at any period of the revolution must therefore have the same relative positions on the tin foil and chemically prepared paper, and further since the current will only flow and decompose the solution during the time the style touches the tin foil, it is evident that the successive makes and breaks of the current will cause successive decompositions of the solution on the prepared paper, and thereby produce, by a succession of broken lines, a facsimile of the design or writing traced on the tin foil, the design appearing in white, and the ground in a colour corresponding to the nature of the chemical solution used. This, if the latter be ferrocyanide of potassium, the ground work will be of a blue colour. The success of the arrangement obviously depends upon the absolute synchronism of the revolution of the two drums, and this, in the apparatus subsequently invented by Caselli, was attained by means of electric pendulums; the arrangement, although successful, being somewhat complicated. A point of novelty in the latter system consisted in causing the style, whilst pressing on the portions of the metallic paper, to short circuit the battery, so that a current only flowed to line when the style passed over the insulating ink. This caused the facsimile on the chemically prepared paper to appear in colour, whilst the ground remained white. Instead of using the rotating drum, the style was caused to traverse backwards and forwards over the surface of the paper.

M. D'Arlincourt in his system employs the rotating drums and traversing style of the Bakewell instrument, and the battery short circuiting method, adopted in the Caselli instrument, but his mechanism for synchronizing the revolution of the two drums is a noticeable point in the invention. Fig. 1 shows generally the principle of the apparatus. *a*, *a'*, are drums provided with styles *s*, *s'*, as in the Bakewell apparatus. Ebonite pieces, *b*, *b'*, flush with the surface and running the full length of the drums, are fixed to the latter, so that when the styles rest on them the latter are insulated. *m*, *m'*, are electro-magnets, which have their armatures normally attracted by means of permanent magnets attached to their cores, as in the Hughes' type printer. The arms of these electro-magnets, when normally attracted, arrest the rotation of the drums when the latter are in the position shewn in the figure. *c*, *c'*, are cams fixed to the axes of the drums, and which have each a projection and a depression, the former of which raise the levers 2, 2', to the positions indicated in the figure, and which cause them to be in contact with studs 1, 1'. The depressions in the cams when the drums commence to rotate, allow the levers to change to the positions where they make contact with the studs 3, 3'. Finally when the drums rotate further, so that the levers press against the continuous surfaces of the cams, their position will be such that they make contact with the studs 2, 2'. *f*, *f'* are levers actuated by the same clockwork which rotates the drums, and which replace the levers *n*, *n'*, on to the cores of the magnets *m*, *m'*, after the drum has fairly commenced to rotate, when released by a current sent through *m* or *m'* as the case may be.

The clockworks which rotate the drums are so arranged that one drum can be caused to rotate at a rate one tenth less than the other. This is accomplished by the device shown in fig. 2.

a, *b*, are two crown wheels, which can slide along, but be rotated by the axle *f f*, which axle is geared indirectly to the drum on which the style presses. *c*, *d*, are two wheels on the axis *g*, which is connected to the speed regulator, which latter can only rotate at a certain definite velocity. In the position shown in the fig., wheels *a* and *d* gear together, but if the crown wheels are shifted to the left, the wheel *b* gears with wheel *c*. Since the relative sizes of the wheels are such that when *a* gears with *d*, the rate of revolution of *f* with *g*, is one-tenth less than it is when *b* gears with *c*, and since *g* at both stations can only rotate at one definite speed, therefore if at one station *a* gears with *d*, and at the other, *b* gears with *c*, then one drum will rotate with a velocity one-tenth less than the other. A small wheel *w* is attached to a spring fixed to the tubular axis on which *a* and *b* are mounted, for the purpose of keeping the wheels firmly in either position to which they may be shifted.

The working of the apparatus may now be made clear:—Supposing B to be the transmitting, and A the receiving station, then the metallic surfaced paper, on which the design or writing is traced, is put on drum *a'*, and the chemically prepared paper on drum *a*. The papers are so wrapped round the cylinder that they cover the whole surface, except the ebonite portions. The clockworks are so geared that *a'* rotates faster than *a*; also by means of a switch, 2' and 3', are connected together. The clockwork at A is now started by throwing *n* permanently out of gear, and drum *a* commences to rotate; as it does so, lever 2' drops from the projection into the depression in the cam and makes contact with 3, this causes a current to pass out to station B where it enters by lever 2', passing to 1', and through *m'* to earth; lever *n'* is thereby immediately released and rises up under the influence of a spring, thereby allowing drum *a'* to start off; immediately it does so, lever 2' drops down to 3' and then up to 2', where it remains during the remainder of the rotation of the drum; *l* in the meantime has risen to 2, so that even if *n* had been in gear the contact made by 2' with 3' would have produced no effect. The two levers being now at 2 and 2' respectively, the marking currents are duly transmitted between the drums. As *a'* rotates faster than *a*, before the lever 2' is again affected, *a'* will have completed its rotation and have been brought to a stop by *n'*, which, as has previously been explained, has been replaced by *f'*; and lever 2' will again have been brought to the position shown in the figure. Drum *a* then, when it has completed its rotation and continued it, again moves lever 2 to 3, again starts off *a'*, and so on; thus drum *a* rotates uniformly and continuously, whilst drum *a'* rotates also uniformly but a little faster than *a*, and is brought up sharp and started off again at each revolution. Practically then *a'* rotates synchronously with *a* and being checked at

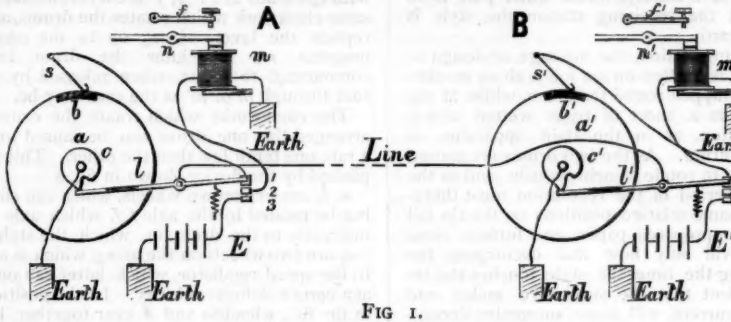


FIG 1.

each revolution can never be more than a tenth of a revolution out, and inasmuch as this one-tenth is distributed over the whole time of the revolution, no appreciable erratic effect is produced in the copy.

As it is very essential that the drum, which is checked at each revolution, should start off with its full velocity when the electro-magnet releases it, the clockwork by which it is turned gears friction tight with it, so that the train continues to run although the drum is stopped, and thus, when the

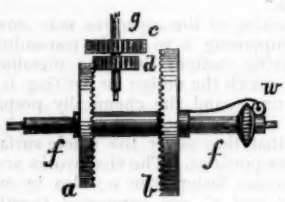


FIG. 2.

latter is released, it at once moves off with the same velocity at which the train is running. As the inertia of a drum, although light, tends to stop the motion of the train, a second train of clockwork quite independent of the first is connected rigidly to the drum, so that the latter is helped to start off quickly.

The motion of the clockwork train that moves continuously is controlled by means of a thick spiral spring governor, like that now employed on the Hughes apparatus. When working long distances a relay is employed, and there are means provided for neutralizing the effect of the static discharge which comes to be felt on long lines, and which would otherwise render the signals highly irregular and prolonged.

FLOOD TELL-TALE.—We learn from the *Moniteur Scientifique* that a new contrivance, invented by U. Camille Gras, for warning towns on the lower reaches of a river of the water level of its upper stream, has recently been tried with success between Laroque-Bouillac and Capdenac, on the river Lot. It consists of a float moored on the surface of the river, and an electric indicator, actuated by the float in such a manner that the needle follows the level of the stream. Indicators may be placed at distant towns, and connected to the float by telegraph. When the river reaches a certain flood level, an alarm bell is rung at these towns, and preparations may be taken against the coming flood.

LE BLANC'S FIRE TELL-TALE.—This ingenious fire alarm (for an account of which we are indebted to *Engineering*) is designed to indicate outbreaks of fire on premises. It is so constructed as to be sensitive to sudden rises of temperature, while it is unaffected by slow variations of the same. The sensitive part consists of two expansible plates of sheet zinc about 60 centimetres long and 0·05 centimetres thick, cut from the same piece so as to be isometric, or having an equal expansion. They are doubled into a gutter shape, so as to be more rigid, and are fixed at one end, while being free to expand at the other. One of these is swathed in flannel, and the other is bare to the atmosphere. When the variations of the temperature in the apartment where the tell-tale is placed are sluggish, the flannel round the covered plate will not interfere with its expansion; and both plates, naked and clothed, will expand equally. But when there is a sudden rise of temperature the bared plate will expand the faster. The effect of this is to make it bring a contact screw which it carries into contact with a spring contact carried by the plate, and the circuit being closed an alarm bell is rung.

ELECTRICITY IN CHINA.—On Tuesday, 1st Oct., we were entertained with a grand display of torpedoes at "Hsiku," near Tientsin, being the annual inspection of the students of the Imperial Torpedo College by H. E. Li Hung-chang. A straight reach of the main river was selected, about a mile in length, and all boat traffic stopped for the day. The students had been busy for two or three previous days laying down cables, joining up torpedoes, &c; and when H. E. arrived at the appointed time many thousands of spectators had assembled on the banks and house tops commanding a view of the situation. The work carried out was a representation on a minor scale of the defence of the channel at Taku. A chart was drawn out, showing the position of each torpedo, and they were fired in the order given by H. E., at the sounding of a bugle. As the last notes of the bugle died away the first charge exploded, throwing up an immense column of water in the air, to the height of three or four hundred feet; this was immediately followed by five other explosions, forming the outer line of defence. On the next word of command, seven torpedoes were simultaneously fired, throwing up a tremendous body of water and shaking the place as by an earthquake; these were followed by seven torpedoes fired singly; after which contact torpedoes were shown, in which heavy charges of powder were exploded, by a steam-launch striking the circuit-closer moored in mid-stream. The experiments were concluded by an array of five torpedo boats advancing in line, each armed with two fifty-pound spar torpedoes, which wheeling round a flag representing an imaginary enemy's ship, launched their torpedoes and fired at a given signal. The boats rose with the upheaving

stream, and were instantly hidden from view by the large volume of water thrown up.

H. E. the Viceroy congratulated Mr. Betts warmly upon the success of the experiments; and calling up the students of the college awarded official rank to several of them and prizes to all, but as each one of the forty-nine torpedoes fired was the work of one individual student, it was difficult to draw a distinction where all were alike successful. H. E. returned to the Yamên at 6 p.m. Now that the inspection is over, the students will at once commence the erection of the Tientsin-Taku telegraph, and the survey for the Tientsin-Paouting-foo-Peking line will be carried out.—*North China Daily News.*, Oct. 9, 1878.

WE have to record the death of Sarah Faraday, widow of Michael Faraday.

Correspondence.

[We do not hold ourselves responsible for the opinions of our correspondents.]

CLERAC'S RESISTANCE TUBE.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—The *Times* for January 2nd contains a report of Professor Barrett's very interesting lecture upon Edison's inventions; but one phrase very much surprises me—viz., that relating to Clerac's variable resistance carbon tube, where Professor Barrett is reported to say that he can find "no trace of it."

Now, as Mr. Clerac entrusted to me in 1866 one of these tubes, which I have employed ever since, and publicly exhibited in all the Continental Telegraph Administrations which I have visited since that date, and as the existence of this tube can be testified to by thousands who have seen it for several years,—and even in London the officers of the Submarine Telegraph Company are ready to testify to my having made use of this tube at their offices in 1871-2,—and as I have the original one in my possession at the present moment, either the reporter of the *Times* has made an error or Professor Barrett has not had full possession of the facts. At the present moment there is a discussion taking place in the *Journal Telegraphique*, Berne, Switerland, in which Professor Zetzsche claims that the variable carbon rheostat was known and used by him before I showed Mr. Clerac's in Berlin in 1866. On this point I am awaiting proof. I believe, however, that prior to Clerac's tube, graphite or carbon was simply used as a solid resistance; whilst the essential part of Clerac's was the means he employed to compress it more or less in order to arrive approximately at the desired resistance. In fact, the only fault with it is that it is not a constant, and requires adjustment every few days if any exact degree is required; but it is exceedingly cheap, and for some purposes answers well enough.

The carbon rheostat brought out by Edison is an exact copy of that by Clerac. He no doubt thought it was original, simply because Clerac's tube was never heralded by any great praise or remarks in journals. Still that does not entitle him to ignore a fact publicly known; and after having been told of the existence of Clerac's tube it was the duty of Mr. Edison's agents to investigate Mr. Clerac's claims, either by reference to Mr. Clerac himself or to those, like myself, who could indicate where all information could be obtained,

I am sure that Professor Barrett wishes for no injustice, and would not ignore Mr. Clerac's claims if he thought them fully substantiated. Now, as I have the original tube in my possession here, and as I have much information I can easily give him or any one interested on the subject if he would kindly visit me at this house, I will show him all that relates to this subject.

94, Great Portland Street, W. D. E. HUGHES.
January 2, 1879.

THE SOURCE OF SOUND IN THE TELEPHONE.

SIR,—I write you to say that the experiments of Prof. Hughes, cited by M. Navez, have not led me to modify in any respect my views respecting the origin of sound in the Bell telephone, properly so called, that is to say *in a telephone without a battery*, and with a current whose force represents (after the recent experiments of M. Galileo Ferraris) that of a Daniell element after traversing a telegraph line, of which the length would be 290 times that of the terrestrial globe. I will never persuade myself that such a current is capable of exercising an effective attraction on a diaphragm of stiff iron. The experiments of MM. Duter and Govi [See TELEGRAPHIC JOURNAL, "Notes," December 15—ED.] have given me occasion to take up the question and to treat it from a higher point of view; and as soon as my researches are completed, I will lose no time in acquainting you with them. What astonishes me in the theoretic deductions of certain persons who have written upon the telephone is, that they have *lost sight of the fact that speech can be transmitted electrically in another manner than by electro-magnetism*, and it is evident to me, that the true theory of the telephone will be that which will embrace all cases of the electric transmission of speech. I have already thrown out some ideas on this point, in the second edition of my work on the telephone; but the more I study the question, the more I am led from the ideas held by M. Navez.

I beg you to receive, Sir, the assurance of my most distinguished sentiments,

Paris, *January*, 2. DU MONCEL.

AN IMPROVED SPEAKING MICROPHONE.

SIR,—In trying Professor Hughes' pencil transmitting microphone, I substituted for the sonorous upright board on which it is usually fixed, a disc of copper, seven and a-half inches in diameter, cut from a sheet that had been used in a Sir W. Thomson tray cell. The microphone was fixed to the side of the disc by means of an interposed piece of insulating wood. With the vibrating board I could get no articulation, but when the disc was substituted for it every word was easily heard in the telephone. The microphone was tried on about 400 yards of underground cable, with seven Minotti cells. I also tried, with the object of increasing the sound, a disc of iron seven and a-half inches in diameter, and about three times thicker than the above-mentioned copper disc, attaching also to the back of the plate the bowl of an electric bell. On lightly striking the bell a loud metallic ring came out on the telephone, with every wave beautifully defined, and, I may add, loud enough for a call signal. Through 100,000 ohms this metallic ring could be still faintly heard with the same battery power as above.

From these experiments I feel sure that the disc supports, whether of metal or wood, in fact anything connected with the microphone that is looked to for sound, should be in unison with the speaker's voice.

G. J. BURRIDGE.

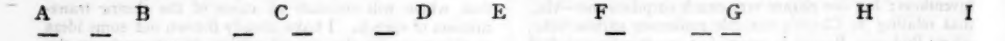
Cable Bay, Nelson, New Zealand.

MR. HERRING'S INSTRUMENT.

SIR,—For the sake of your non-telegraphic readers, it appears to me very desirable that the recent article you devoted to Mr. Herring's device should not be allowed to pass without a remark or two, suggested as much by practical experience as by long consideration of the subject. At one time, indeed, I must have owned to a certain bias in favour of Mr. Herring, having myself met, under somewhat similar circumstances, with what I regarded as scant justice from the late engineer-in-chief of the Post Office; but increased knowledge has long since convinced me that the "eternal fitness of things," and not the Postal Telegraph authorities, is the real enemy with which Mr. Herring has to contend. One is truly at a loss whether to admire most that gentleman's "dogged resolution," or deplore his apparent lack of practical familiarity with current telegraphic requirements, whereby he remains, as it were, for ever whirling round and round in the back-water of invention.

Had he been content to apply his system to needles, Bright's bells, and similarly-worked instruments, the question would lie within very narrow limits; but when, in place of the universal Morse Alphabet and Varley's immortal "Double Current," he proposes to introduce his own peculiar "longs and shorts," worked by single current reversals, we may well enquire whether the proposed cure is not really worse than the alleged disease. Mr. Herring evidently believes that the horizontal dot and dash are apt to be mistaken one for another; but the fact is—as ninety-nine clerks out of a hundred would tell him—that "bad spacing," and not imperfect dots or dashes, cause most trouble and produce by far the largest number of mistakes.

A B C D E F G H I



I cannot digress to such an extent as would enable me to satisfactorily account for this failing, interesting as the point is, but simply enquire, will Mr. Herring's system be free from the same defect? Presuming the use of "tapper keys" for sending, I fear, the evil would be increased rather than diminished. For instance, look at the enclosed specimen "slip" taken in a somewhat similar manner as Mr. Herring's, except that the marks are horizontal, and are produced by two parallel printing discs one or both of which act as the left or right key is depressed at the sending station. This being my own device, and constantly joined up to a "Bell" circuit, *might* be always "turned on," but is not. Why? Because the attendant labour of even winding up the machine, let alone paper, tear and wear, &c., would not justify the possible gain of, perhaps, tracing by it two or three errors in a twelvemonth. The whole question is, clearly enough, one of expediency. The Postal Telegraphic authorities find they can get on very well without these recorders, and it is, therefore, a thankless thing to put in their way what they don't want.

The retention of visual systems will, to some slight extent (apart from automatic working) be unavoidable; but it is to the *ear* and not the eye that we now principally trust, and daily experience proves that our confidence is not misplaced. With sounders, receiving clerks are obviously obliged to "keep up" with the senders, and in the case of moderately sized offices, Postmasters or Superintendents are never at a loss to know what is going on, while as regards "calling," and liability to inattention, the voice of the sounder is not a thing to be ignored, its very importunity compelling attention.

With all respect, therefore, to Mr. Herring, I cannot help thinking how much greater service he can render to practical telegraphy by "rising upwards," working out "this printing delusion," and betaking himself, heart and soul, to the improvement of sounders. Then, and not till then, can he hope to earn the gratitude of operators or win the admiration of your humble servant,

O.P.O., Christmas Day, 1878. M.

MODE OF REGULATING THE CONTACT PRESSURE IN A MICROPHONE.

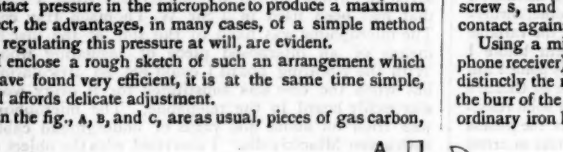
SIR,—Assuming that sounds of varied intensity, and, perhaps those of different timbre, require a different degree of contact pressure in the microphone to produce a maximum effect, the advantages, in many cases, of a simple method for regulating this pressure at will, are evident.

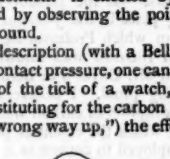
I enclose a rough sketch of such an arrangement which I have found very efficient, it is at the same time simple, and affords delicate adjustment.

In the fig., A, B, and C, are as usual, pieces of gas carbon, *i*, *i*, are binding screws connected with the carbons A, B. In the end view, the carbon C has been removed.

The carbons A, B, can be adjusted to approximate position by sliding in their support, and then the third carbon being suspended, the fine adjustment is effected by the screw S, and may be facilitated by observing the point of contact against a white background.

Using a microphone of this description (with a Bell telephone receiver), by varying the contact pressure, one can hear distinctly the respective sounds of the tick of a watch, and the burr of the wheel work. Substituting for the carbon C an ordinary iron key (suspended "wrong way up,") the effect is still stronger (chiefly due to the greater stability of the contact below being thus less easily affected by air currents, &c).





A and B fitting tightly in the upright wooden support. A terminates, as shown, in a point which is lodged in a slight concavity in C, thus the latter is freely suspended above, while it makes contact beneath with B at *one* point, the intersection of two knife edges at right angles.

The microphone table is supported by three feet, two in front fixed, the third (S) behind consists of a small thumb screw, turning easily in the wood.

I have also made on the same principle a microphone with only two carbons, one fixed horizontally and pencil pointed, the other forming the bob of a short pendulum, suspended by a fine conducting wire, but owing to the stiffness of the wire, it is not quite so suitable.

Seraing, Belgium. R. LAWRENCE.

Notes.

THE ELECTRIC LIGHT.—In our account of Jablochkoff's electric candle in our last issue we stated that Messrs. Wells & Co., Shoreditch, were the agents for the *Société Generale* in England. It appears that this is erroneous, and that Messrs. Wells & Co. are merely sub-contractors. The sole representative for this company in England is Mr. J. A. Berly, C.E., 139, Cannon Street, E.C.

EDISON'S ELECTRIC LIGHT.—According to Mr. Edison the cost for each electro-pyre, or electric burner of 20-candle power per year will be 1·95 dollars, as against 15 dollars for gas (in America).

APPLICATION for a third English patent for electric lighting has been lodged by Messrs. Brewer and Jensen on behalf of Mr. Edison. It appears to include a new dynamo-electric machine.

THE *Athenæum* reports that Mr. Edison has made arrangements for the production in England and America simultaneously of a book by him on the Electric Light. The English publishers will be Messrs. Sampson, Low, & Co., the American, Messrs. Harper, Brothers. The book will contain a full account of Edison's electric lighting system; and it is delayed for the present until the completion of the patents.

THE vital feature of Edison's plan for electric lighting consists in making each lamp in circuit absolutely independent of the variations of current in the circuit. Each lamp, by means of a regulator, the principle of which is not divulged, draws just sufficient current from the main to keep up a given intensity of light, whatever be the number of lights fed by the circuit. It may be conjectured that the regulator is based on the variable resistance of carbon under pressure, the pressure being produced by a heating or magnetic effect of the current.

LAST night he (Edison) made a discovery at four o'clock in the afternoon. He got a wire from Menlo Park to Plainfield, where his solicitor lives, and brought him into the telegraph office at that place. Mr. Edison wired him the discovery. He drew up the specifications on the spot, and about nine o'clock cabled an application for a patent to London. Before people were out of bed next morning, Mr. Edison received information that his application had been filed in the English Patent Office. The difference between London and New York time explains the matter.—*The Operator*, U.S.

WE hear that Mr. Edison has been over-working himself so much that chloroform had to be administered to make him sleep.

WERDERMANN'S ELECTRIC LIGHT.—*Apropos* of M. Reynier's claim of priority, Mr. Werdermann has explained to the Academy of Sciences, Paris, that his lamp is not based on the incandescence of carbon but on the formation of a very small arc or bead of light at the junction of the electro-pyres; the red-heating of the carbon being a concomitant not an aim of the system.

Touching this controversy, Dr. Cornelius Hertz writes to *L'Electricité* pointing out that Reynier's plan is a copy of Harrison's "rotating disc and pencil" method, patented in England in 1857.

WILDE'S ELECTRIC CANDLE.—The reason why the luminous arc in Wilde's electric candle locates itself at the extremity of the carbon rods, whether the candle be erect or inverted, is explained by Mr. J. Hopkinson in a letter to *Nature*. It is that the current in each carbon repels the arc in the same way as the current in the mercury trough repels the connecting cross-wire in a well-known experiment of Ampère. The inclined currents in arc and carbon are unlike in direction, and therefore repel each other.

WE hear that the Raffael Gallery in the South Kensington Museum is to be lit by Wilde's system.

THE WALLACE-FARMER ELECTRIC LIGHT has been fitted up, under the supervision of Dr. Sylvanus Thomson, in the tobacco factory of Messrs. W. D. and H. O. Wills, the well-known manufacturers of "Bristol Birds' Eye." The light is of special value in the "leaf" room where the tobaccos, when turned out of the hogsheads in their imported condition, are sorted with the greatest care, in order to get the finest and ripest leaves for the choicest brands of the firm. In this task the sorters are chiefly guided by the colour of the leaves, the tobacco of one growth in a single hogshead varying so much that every portion of it has to be assorted. For this delicate purpose the electric light is all that is required.

A COMPANY is being formed to work the Wallace-Farmer light.

THE ELECTRIC LIGHT FOR INDIA.—We have received from the India Office a précis of the report of Mr. Schwendler, the Government Superintendent Electrician, on the experiments conducted by him at the Indian Store Department, Belvedere Road, Lambeth, to test the suitability of the electric light for India. From these experiments Mr. Schwendler has come to the conclusion that there "is a considerable balance of evidence in favour of the introduction of the electric light into Indian railway stations." He therefore recommends a practical trial of it at the Allahabad or at Hourah Station. The machines tried were two Siemens-Altneck machines (size, medium and small) and two Gramme machines (one a workshop pattern supplied by Messrs. Soutter and Lemonnier, Paris, the other supplied by the British Telegraph Factory). Of these, Siemens' medium size has been found most efficient, and is with certain modifications recommended. The lamps tried were the Serrin and the Siemens, the former being preferred. We shall have occasion to refer to this report again.

ACCORDING to Prof. Anthony, of Cornell University, oil consumed in the steam engine will yield an electric light of three-fold power to the light which it will give on being burned.

MR. WHITELEY'S UNIVERSAL STORE is to be illuminated by the electric light; so also is the Langham Hotel, that famous haunt of travelling Americans. The British Electric Light Company are to undertake the latter work. The Crystal Palace is to be lit by the Sun Electric Lighting Company.

FARMING BY ELECTRIC LIGHT was successfully practised in France during last season. M. Albaret's arrangement is considered very well adapted to the purpose. It consists of a portable engine of four or five horse-power, carrying an iron mast from sixty to eighty feet high. This engine drives a Gramme magneto-electric machine, and the lamp which is hung from the top of the mast. The mast, which is com-

posed of numerous iron tubes, can be raised or lowered at will by a winch at its base; and the lamp can be slung high or low by means of a rope and pulleys.

CHEMICAL EFFECTS OF THE ELECTRIC ARC.—At the meeting of the Chemical Society on December 13th ult., Mr. T. Wills read a paper on experiments which he had made to determine whether or not nitrogen gas was oxidised by the electric arc. The current from 60 Grove's cells was used for generating the light. The carbon points were placed under an inverted funnel, and the air supplied was aspirated through dilute potash to purify it. The nitrates formed were converted into ammonia with aluminium, &c. Nitric peutoxide, $N_2 O_5$, was formed at the rate of about 0·65 grammes per hour. Dr. Gladstone observed that the amount of nitric acid was very considerable; and Dr. Frankland expressed surprise at the result, for he had used the electric light for twenty years without observing any corosion of the brass or delicate clockwork of the lantern. The production of so much nitric acid under all circumstances with the electric light would be a serious drawback; but it could be overcome by enclosed lights of the Sawyer-Man type. Mr. Wills is to continue his experiments with currents derived from the Siemens' machine.

THE ALBO-CARBON LIGHT.—The Dundee Gas Commissioners have been investigating the question of the albo-carbon light, and they find that by the use of albo-carbon or napthaline, the illuminating power of the gas now supplied can be doubled, that is to say, 1,000 feet of gas supplemented by 1¼ lbs. of albo-carbon will give an illumination equivalent to 2,000 cubic feet of gas burnt in the ordinary way. The cost of albo-carbon per lb. is given on good authority as from 3d. to 4d. per lb. Taking it at 6d. per lb. the cost of gas in Dundee, burnt by the albo-carbon process is given as follows:—

1,000 feet ordinary gas	...	3s. 9d.
1¼ lb. Napthaline, at 6d. per lb.		0s. 10½d.
		4s. 7½d.

Thus an illumination by the albo-carbon process, costing only 4s. 7½d. would, by the ordinary plan (2,000 cubic feet at 3s. 9d.), cost 7s. 6d. It is probable, too, that by increasing the quantity of carbon consumed per 1,000 feet, a greater illuminating power could be obtained than is adopted in the above estimate.

THE TELEPHONE.—At a meeting of the American Academy of Arts and Sciences on Dec. 11th last, Prof. Graham Bell read a paper on the use of the telephone in tracing equi-potential lines and surfaces. He showed that for this purpose it was a better instrument than the galvanometer. He used a steel band telephone which could be clasped about the head, leaving the hands free to perform the experiments. By the use of metal exploring rods, the equi-potential lines could be traced in the ground under the observer's feet, or in the neighbourhood of metallic deposits, and in this way veins of ore, or peculiarities in the homogeneity of the earth might be discovered.

EDISON'S new telephone receiver is reported to render even a whisper audible to a person standing fifteen feet away.

CLERAC'S TUBE.—The controversy about the microphone and carbon telephone elicited the fact that M. Clerac, of the French Telegraph Administration, had discovered the property possessed by powdered carbon of varying its resistance under pressure as far back as 1865, when he applied it in the construction of variable resistance rheostats formed of tubes filled with powdered wood charcoal, coke, or graphite, which was compressed more or less to alter its electric resistance, by screws in the ends of the tubes. This property was re-discovered by Mr. Edison, and most ingeniously made use of in the invention of his carbon telephone. But there can be no doubt that Clerac observed the property in question long before Edison. In the most recent numbers of the *Journal Telegraphique*, Dr. Zetzsche has challenged Clerac's claims, alleging that carbon resistances were used prior to 1866 in Germany; but his remarks appear to apply to solid carbon resistances and not to variable ones of carbon dust. On this head we refer our readers to Prof. Hughes' letter published in our correspondence; and we may add that through the courtesy of Mr. Hughes we have seen the tube in question.

THE microphone is stated to have been at last successfully applied to auscultation of the heart by Surgeon-Major Wallich. According to the *Lancet* the water dropping from the esophagus into the stomach could be heard when it was applied to the stomach.

THE Raja Sir Madava Row, K.C.S.I., Dewan of Baroda, has pointed out two possible uses for the microphone peculiar to India. It appears that certain high Indian ladies would rather die of decline than allow the doctor to examine their lungs in the ordinary manner by stethescope; but with a microphone attachment they would no doubt submit to the process, the medical man being in this way kept at a distance. The other case consists in applying the microphone to the soil to detect the murmur of water flowing in underground strata, and thus indicating the places at which to bore wells. These spots are now selected by professional jugglers, who discover them by laying their ear to the ground in the silence of night.

THE PHONOGRAPH.—The phonograph appears to be degenerating, now that Mr. Edison has been forced to neglect his favourite offspring, and its articulation is getting worse and worse. We are sorry to hear that at a recent exhibition in a country town the well-known lines of Milton's L'Allegro—

> "But come thou Goddess fair and free,
> In heaven y-clep'd Euphrosyne."

were rendered by that incorrigible instrument as

> "But come thou Goddess fair and free,
> In heaven she crept, and froze her knee."

URGENT TELEGRAMS.—M. Linckens, of the Netherlands telegraph service, has been deputed to examine the results of the urgent telegram system, which has been tried there since last October. He finds that while over half of the Bourse telegrams are urgent hardly any come from private sources. M. Linckens is of opinion that the total number of urgent telegrams is not high enough to delay the ordinary traffic, and that these urgent telegrams render incontestable service to their senders.

GERMAN TELEGRAPHS.—According to the *Cologne Gasette* the Imperial German Government intend during the present year to push forward the works of the subterranean telegraph. It is proposed to lay the line between Cologne and Metz, which will cross the Moselle and the Sieg. The Bridges of Coblentz and other places will be utilised for this purpose, but a river cable will be laid across the Sieg at Siegburg. The subterranean cable will be constructed to correspond with

those already existing between Berlin and Halle, and Berlin and Frankfort-on-the-Maine. The Reichstag will be asked to vote the necessary funds.

A NEW FRENCH ATLANTIC CABLE.—This project, which we announced in our last, is promoted by the *Société de depots et comptes courants*, the *Société financière*, and the *Credit industriel et commercial*, who have united to lay a Franco-American cable line from Paris to New York, which will be worked by a new company, the *Compagnie Française du telegraphe de Paris à New York*.

AT a pleasant conversazione, held in the Argyleshire Gathering Hall at Oban, on December 20th last, the telegraph was prominently represented by Mr. McLean, the postmaster of the town. A number of telegraphic appliances were shown at work by Mr. McLean; and the Highland folk had an opportunity of hearing the telephone. Judge of their delight when they found that it could speak "the gælic."

A TELEGRAPH line is being erected from Durban to Hangan, a place about twenty miles from the Zulu border, and near the coast.

WE learn from the *Journal Télégraphique* that on taking possession of the Dobrudscha the Roumanian government established eleven telegraph offices, forming a permanent service open to international correspondence. The Russians, however, would not permit them to open an office in Sulina.

THE French Government recently presented to the *Corps Législatif* a project for laying a cable between Australia and New Caledonia.

THE Eastern Telegraph Company, on the completion of their land lines in Cyprus, have suppressed the extra tax of 25 centimes for messages beyond Larnaca, the rate from Alexandria to Larnaca holding good for the whole island.

A NEW cable is to be laid between Manilla and Hong Kong, by the Spanish government.

M. BLAVIER has been nominated director of the Paris Superior Telegraph School, during 1879. M. Mercadier is professor of Physics, and M. Bontemps is professor of telegraphy.

MR. CH. BONTEMPS, chief of the pneumatic service of the French Telegraph Administration, has issued a work entitled *Les Systèmes Télégraphiques*, published by Dunod, Paris, price 8 francs.

THE TELEGRAPH IN THE YELLOWSTONE REGION, U.S.—The telegraph line from Deadwood to Fort Keogh, Montana, has been completed. This line opens Central Montana and the Yellowstone up to communication with the outside world, through the Black Hills and Cheyenne Telegraph line with which it connects.—*Journal of the Telegraph*, U.S.

TELEGRAPHY IN JAPAN.—Mr. E. Gilbert who for upwards of the past four years has had charge of the Government Telegraph Department as Superintendent-in-chief, but whose engagement is about to terminate, was entertained by the Acting Minister of Public Works, Yamao Yozo, at a banquet at Shiba Palace. Its Hirobumi, the Minister for the Home department, and about thirty other gentlemen were present. A very cordial and pleasant evening was spent, and all united in expressions of good will and good wishes for Mr. Gilbert's future happiness. We believe Mr. Gilbert has given the Government ample satisfaction from the way in which he has conducted the important department under his charge, and leaves the lines of telegraph in as excellent a condition as the best lines in any part of the world.—*Japan Daily Herald*.

JAPAN INSULATORS.—The *Japan Mail* is responsible for the statement that telegraphic insulators made at the village of Imari, in the province of Hizen, are so good that they find a large sale in Europe.

MUIRHEAD'S DUPLEX SYSTEM is to be applied next to the Porthcurnow and Vigo section of the Eastern Telegraph Company's system. Dr. Muirhead has proceeded to Vigo for that purpose.

FOREIGN ELECTRICAL WORKS.—The following are the most recent electrical publications:—*Laroboh i Telegraft*, by C. A. Nyström (Stockholm: F. and J. Beijer, 1878); *Die Harmonie der Töne und des Lichts*, by A. N. Bohner (C. Rümpler, Hanover); *Weiter Zur Kenntniss der Coarcitivkraft des Magneteisensteines und des Glasharten Stahles*, by A. L. Holz (Jena); *Ueber Theorie und Anwendung der Elektro-magnetischen Rotationem*, by M. Margules (Gerold, Vienna); *Die Telegraphentechnik der Praxis*, by A. Merling (Carl Meyer, Hanover); *Telegrafie Electrique*, by L. Honzeau (Paris); *Ueber den Vorlauf der Funkenwolke in der Ebene und in Raume*, by E. Mach (Gerold, Vienna); *La Elettricita e il Telegrafa*, by C. Pianta (Milan); *Die Magnet und Dynamoelektrischen Maschinen, ihre Entwickling Construktion und Praktische Anwendung*, by H. Schellen (Du Mont Schauberg, Cologne); *Nuovo Compendio di Telegrafia Elettrica*, by G. Tamburello-Santemgelo (Palermo); *Resumé des cours Elementaire de Telegraphie Electrique*, by H. Cailleret (Lille).

Reviews.

Instructions for Testing Telegraph Lines, and the Technical Arrangement of Offices. By LOUIS SCHWENDLER. Vol. I., Second Edition. London: Trübner & Co., Ludgate Hill. 1878.

THE introduction to this work states that the testing instructions were originally written for the special use of the staff of the Government Telegraph Department in India, in order to facilitate the introduction of a rational system of testing the lines, and the technical arrangement of telegraph offices. Since these instructions were drawn up, the author has made considerable additions in the shape of a number of pamphlets, and these he has now combined with the necessary alterations, into the volume which has just been published, and into a second, which will be published later on.

Mr. Schwendler, at the latter part of the introduction, states that he "has been surprised to find how little progress Testing has made. I was always told (he says) "Yes, we should like to introduce a general system of Testing; we know its practical utility; but show us a system to do it, and which will work satisfactorily." We must confess that we are equally surprised with the author, but

our reason for being so is, that this statement should have been made without qualification. Writing, as the author does, from the metropolis of the kingdom which possesses one of the most efficient telegraph systems in the world, we think it surprising that he should not have taken the trouble to enquire whether any system of Testing existed in the Postal Telegraph Service; if he had done so he would have found that a system did exist, and that this system although not so elaborate as that drawn up for use in the Indian Service, was as equally efficient.

As regards the other telegraph administrations, we very much doubt whether the systems advocated, although thoroughly efficient for the purpose for which they were drawn up, would be of much use to them, though no doubt very many useful hints might be taken from the work, and for that reason the latter is of practical utility.

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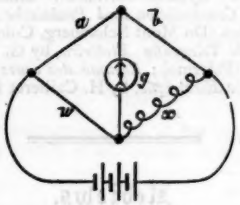

The conclusion Mr. Schwendler comes to is that for maximum sensibility, the four arms a, w, b, and x, should be equal; that is to say, if x be the unknown resistance, a rough measurement should be first made, so as to determine approximately its value, and then a and w should be made alike and as nearly equal to x as possible, and so that by adjusting b exactly, we get, $x=b$. Such an arrangement of the resistances is supposed to give maximum sensibility, because any small change in the value of b (supposing the latter to be the adjustable resistance) produces the greatest deflection on the galvanometer g. This we do not deny, although Mr. Schwendler's proof is by no means an easy or clear one to follow, but it is not true that this condition of maximum sensibility is the one for obtaining maximum *accuracy*.

It must be perfectly evident that with the sides a and w equal, if b is adjustable only to units, as is usually the case, no matter how sensitive the system may be, we cannot determine the value of x to a closer accuracy than 1 unit; if, however, we have a 10-times w, then every unit in b represents 1 unit in x, so that even supposing the sensitiveness of the galvanometer were only sufficient to enable an adjustment of 10 units in b to be made with accuracy, we should still be able to determine the value of x within 1 unit, since, as we have pointed out, 10 units in b represent 1 unit in x. But it may be objected, supposing balance to be obtained, that the alteration of 10 units in b, with a ten times as great as w, would not produce as great a deflection of the galvanometer needle as would 1 unit in b when a and w are equal; this may be so, but still that deflection may be sufficiently great to enable a closer adjustment than 10 units to be attained; in fact, as is well known, such is very frequently the case; with a Thomson galvanometer no one would think of having a and w equal, simply because that is the most sensitive arrangement. As long as any perceptible deflection can be perceived by an alteration of 1 unit in b, the greater a is made than b the more accurately can the value of x be determined.

Again, granting, as we said before, that the proof given is correct, Mr. Schwendler does not prove, what is really of much more importance, that the rigid rule laid down by him may be departed from to a very great degree without the sensitiveness of the system being materially reduced. In fact, it admits of proof that a may be made ten times as great as w, and yet the sensitiveness of the system be but very little diminished. Thus, if with a and w equal we obtained, by an alteration of 1 unit in b, a deflection from zero of 3°, then with a ten times w, an alteration of 10 units in b (which corresponds to 1 unit in x), would only reduce this deflection to about 2°.

We have entered into this question at some length for the reason that the common method of obtaining the conditions of maximum sensitiveness in any test by the differential calculus is misleading. The proper course to pursue is to put the equations representing the conditions for sensibility into such a form that an analysis can be made, and the limits of the conditions seen by mere inspection. It is by no means difficult to do this, and the insight which it gives into the questions will be found to be somewhat surprising to those who have not made the attempt.

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ABSTRACTS OF PUBLISHED SPECIFICATIONS

1326. "Interlocking apparatus for the points, &c., of railways." C. HODGSON. Dated June 13, 1878. 8d. This describes a means whereby the interlocking gear can be used in connection with telegraph instruments working with one line wire, without interfering with the ordinary use of these instruments on the wire.

1370. "Telephones." A. PARIS, Hamburg. (C. HODGSON.) Dated April 6, 1878. 6d. This consists in a plan for putting the telephones in circuit with the line for speaking, by simply lifting them from hoppers or receivers where they rest when not in use. When on the hoppers the line is in connection with the signal bell or alarm used in connection with the telephones.

1375. "Signalling on railways." T. T. POWELL. Dated April 6, 1878. 6d. This consists in means of communication between different parts of a train, and in a mode of acquainting the signalman of the position of a train on his block.

1419. "Transmitting messages." M. T. NEALE. Dated April 9, 1878. 6d. This consists of a pneumatic despatch for private use. Small carriers containing the written messages are sent along tubes on compressing the air behind them by means of a piston.

1467. "Originating and developing electric currents." H. C. SPALDING. Dated April 12, 1878. 2d. A series of dynamo-electric machines are to be employed together, so that a feeble current generated in the first shall, on passing through the rest successively, be greatly intensified. *Not proceeded with.*

1519. "Apparatus for raising ships, anchors, and telegraph cables, &c." H. SCHALLEN. Dated April 16, 1878. 8d. The grapnels described therein as specially adapted for cable lifting consist, firstly, of a shank having a curved prong, in the cusp of which is a carved shamrock-leaf recess, into which the cable falls and is retained, and secondly, of a shank with serrated clip prongs, that is, jaws which close on the cable like pincers when it is hooked and being hauled up.

1522. "Galvanic batteries." PETER GRABINGER, Athens. Dated April 16, 1878. 2d. This describes the well-known Leclanché element. *Not proceeded with.*

1564. "Apparatus for igniting and extinguishing gas by electricity." J. W. BARTLETT, New York. Dated April 18, 1878. 4d. An electro-magnetic apparatus whereby a spark is caused to pass through the gas on breaking the circuit. *Not proceeded with.*

1613. "Telegraphy." J. B. MANGENOT, Paris. Dated April 22, 1878. 6d. This consists in a field telegraph, the currents being generated by a magneto-electric rotary machine. The receiver consists of two terminals side by side but insulated from each other, and connected to earth and line respectively. When pressed on the finger, cheek, or tongue (according to the strength of the received currents) a slight shock will be felt at each signal.

1644. "Recording and reproducing sounds. T. A. EDISON. Dated April 24, 1878. 10d. This describes Edison's phonograph, and the various kinds of "phonograms" or sound-records obtained, as well as the "phonets," or apparatus for reproducing the sounds from the phonograms, which may be used.

Proceedings of Societies.

PHYSICAL SOCIETY.

AT the meeting on December 14, Prof. W. G. ADAMS, President, in the Chair.

Prof. GUTHRIE read a note by Mr. C. Boys on a Condenser of Variable Capacity. This condenser was designed for use in connection with the Holtz machine to shew the effect of condensation on the length of the

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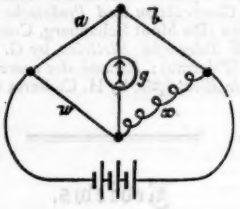

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5321. "Underground telegraph lines." J. S. PIERSON. Dated December 30.

ABSTRACTS OF PUBLISHED SPECIFICATIONS

1326. "Interlocking apparatus for the points, &c., of railways." C. HODGSON. Dated June 13, 1878. 8d. This describes a means whereby the interlocking gear can be used in connection with telegraph instruments working with one line wire, without interfering with the ordinary use of these instruments on the wire.

1370. "Telephones." A. PARIS, Hamburg. (C. HODGSON.) Dated April 6, 1878. 6d. This consists in a plan for putting the telephones in circuit with the line for speaking, by simply lifting them from hoppers or receivers where they rest when not in use. When on the hoppers the line is in connection with the signal bell or alarm used in connection with the telephones.

1375. "Signalling on railways." T. T. POWELL. Dated April 6, 1878. 6d. This consists in means of communication between different parts of a train, and in a mode of acquainting the signalman of the position of a train on his block.

1419. "Transmitting messages." M. T. NEALE. Dated April 9, 1878. 6d. This consists of a pneumatic despatch for private use. Small carriers containing the written messages are sent along tubes on compressing the air behind them by means of a piston.

1467. "Originating and developing electric currents." H. C. SPALDING. Dated April 12, 1878. 2d. A series of dynamo-electric machines are to be employed together, so that a feeble current generated in the first shall, on passing through the rest successively, be greatly intensified. *Not proceeded with.*

1519. "Apparatus for raising ships, anchors, and telegraph cables, &c." H. SCHALLEN. Dated April 16, 1878. 8d. The grapnels described therein as specially adapted for cable lifting consist, firstly, of a shank having a curved prong, in the cusp of which is a carved shamrock-leaf recess, into which the cable falls and is retained, and secondly, of a shank with serrated clip prongs, that is, jaws which close on the cable like pincers when it is hooked and being hauled up.

1522. "Galvanic batteries." PETER GRABINGER, Athens. Dated April 16, 1878. 2d. This describes the well-known Leclanché element. *Not proceeded with.*

1564. "Apparatus for igniting and extinguishing gas by electricity." J. W. BARTLETT, New York. Dated April 18, 1878. 4d. An electro-magnetic apparatus whereby a spark is caused to pass through the gas on breaking the circuit. *Not proceeded with.*

1613. "Telegraphy." J. B. MANGENOT, Paris. Dated April 22, 1878. 6d. This consists in a field telegraph, the currents being generated by a magneto-electric rotary machine. The receiver consists of two terminals side by side but insulated from each other, and connected to earth and line respectively. When pressed on the finger, cheek, or tongue (according to the strength of the received currents) a slight shock will be felt at each signal.

1644. "Recording and reproducing sounds. T. A. EDISON. Dated April 24, 1878. 10d. This describes Edison's phonograph, and the various kinds of "phonograms" or sound-records obtained, as well as the "phonets," or apparatus for reproducing the sounds from the phonograms, which may be used.

Proceedings of Societies.

PHYSICAL SOCIETY.

AT the meeting on December 14, Prof. W. G. ADAMS, President, in the Chair.

Prof. GUTHRIE read a note by Mr. C. Boys on a Condenser of Variable Capacity. This condenser was designed for use in connection with the Holtz machine to shew the effect of condensation on the length of the

spark. It consists of a test-tube coated externally with tinfoil to form the inner armature, and a glass tube enclosing the test-tube, and having its outer surface covered with tinfoil for the outer armature. The inner tube can be slid out or in along the length of the external tube, and the capacity thereby varied. Prof. Guthrie showed that a spark from the Holtz machine could by its means be gradually reduced. Prof. McDonnel states that he had for some years used a similar apparatus, the inner coating, however, being strong sulphurous acid.

DR. O. J. LODGE exhibited a Differential Thermometer, in which saturated water vapour took the place of air or other gas; and based on the fact that the pressure of saturated vapour, in contact with its liquid, depends only on the temperature. An ordinary cryophorus held nearly horizontal, answers very well; any difference of temperature between the bulbs causing a difference of level between the liquid in the stem and that in the adjacent bulb. The instrument is, however, only correct for low temperatures; but will serve as a delicate thermoscope for class purposes.

MR. W. CLARK gave the surface tension of liquid sulphurous anhydride as derived from its capillarity as 2·3 milligrammes per square millimetre at — 15° C.

City Notes.

Old Broad Street, Jan. 13th, 1879.

IN our last issue we mentioned that the Franco-American Cable Scheme was about to be brought forward. A Maclean's telegram of the 10th inst. from Paris states that the aforesaid company, formed to carry out M. Pouyer-Quertier's Concessions, has been constituted, and the prospectus has been issued. The capital is 52 millions of francs, with a first issue of 42 millions in 84,000 shares. It is proposed to lay two cables, viz., from Brest to Cape Cod, and from Land's End to Nova Scotia, both *via* Saint Pierre.

On the 4th inst., we were informed by the Secretary of the Direct U. S. Cable Company that a defect had appeared in the cable of that company near the shore at Torbay, delaying the transmission of messages, which, until the fault is removed, will be forwarded by the Anglo route.

The Eastern Extension Telegraph Company notified on the 9th inst., the repair of their Singapore Batavia Cable, thus restoring direct telegraphic communication with Java, Australia, and New Zealand.

A dividend has been declared by the Great Northern Telegraph Company for the past half year at the rate of 5 per cent. per annum on its share capital of £1,500,000.

The Stock Exchange Committee have ordered the reduced capital of the India-Rubber, Gutta-Percha and Cable Work's Company to be quoted officially, and to be marked ex-West Coast Shares.

The following are the latest quotations of telegraphs:—Anglo-American, Limited, 58½-59¼; Ditto, Preferred, 83½-84½; Ditto, Deferred, 33-34½; Black Sea, Limited, —; Brazilian Submarine, Limited, 6½-6¾; Cuba, Limited, 8¼-8½; Cuba, Limited, 10 per cent. Preference, 15¼-15½; Direct Spanish, Limited, 1½-2; Direct Spanish, 10 per cent. Preference, 9½-10½; Direct United States Cable, Limited, 1877, 11½-11⅝; Eastern, Limited, 7¼-7⅜; Eastern, 6 per cent. Debentures repayable October, 1883, 104-107; Eastern 5 per cent. Debentures repayable August, 1887, 101-104; Eastern, 6 per cent. Preference, 11½-11⅝; Eastern Extension, Australasian and China Limited, 7-7¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 105-108; German Union Telegraph and Trust, 8-8¼; Globe Telegraph and Trust, Limited, 4¾-5⅛; Globe, 6 per cent. Preference, 10¼-10½; Great Northern, 7⅛-7⅜; Indo-European, Limited, 19-20; Mediterranean Extension, Limited, 2½-3; Mediterranean Extension, 8 per cent. Preference, 8½-9½; Reuter's, Limited, 9½-10½; Submarine, 217-222; Submarine Scrip, 1⅞-2⅛; West India and Panama, Limited, 1⅞-2⅛; Ditto, 6 per cent. First Preference, 8-8½; Ditto, ditto, Second Preference, 7½-8; Western and Brazilian, Limited, 2¼-2⅜; Ditto, 6 per cent. Debentures "A," 87-92, Ditto, ditto, ditto, "B," 84-88; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 114-118; Ditto, 6 per cent. Sterling Bonds, 101-103; Telegraph Construction and Maintenance, Limited, 29-30; Ditto, 6 per cent. Bonds, —; Ditto, Second Bonus Trust Certificates, 2⅛-2⅜; India Rubber Co., 8¾-9¼.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £9,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,102,420.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£ [b]	£	£	£ [b]	£
December, 1878	47,040	14,231	2,800	940	13,970	38,467	22,929	14,803	... ...	8,498	... ...	... ...	5,304
December, 1877 ...	45,570	12,318	2,666	858	12,930	37,777	23,980	15,511	... ...	8,754	... ...	... ...	4,558
Increase	1,470	1,913	134	82	10,40	690	... ...	... ...	... ...	... ...	... ...	... ...	746
Decrease	... ...	... ...	... ...	... ...	... ...	... ...	1,051	708	... ...	256	... ...	... ...	... ...

[b] Not published.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness.)